NEW BUR TECHNOLOGY USING SPUNBONDED POLYESTER REINFORCING FABRICS

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Spunbonded polyester fabrics, new reinforcing felt for built-up bituminous membranes, may ultimately solve two major problems: membrane splitting and flexural fatigue cracking. Compared with organic and glass fiber reinforced membranes, the polyester fabric reinforced membrane is in a class by itself. Its breaking strain ranges up to 20 times the breaking strain of conventional membranes; flexural fatigue resistance ranges from 100 to 1,000 times as high.

Note, however, an important current limitation: The tested membranes were cold-process, not hot-applied membranes. (Interply mastic adhesive was applied at the rate of 2.5-3 gal/sq., see Figures 1 and 2.) Polyester fabric is sensitive to high temperatures, a consequence of its thermoplastic nature. For this reason, spunbonded fabrics cannot be hot-mopped via standard BUR practice. Hot-mopping temperatures of 450°F-475°F will cause dimensional changes.

Polyester-reinforced membrane has, however, been constructed with Type II asphalt applied at 400°F, with no dimensional changes. The hot-applied polyester-reinforced membrane, now 3½ years old, is still giving problem-free service (see Fig. 3).

For the cold-applied, polyester-reinforced membranes, interply adhesive asphalt is almost always either a cold-applied asphalt cutback (per ASTM D2823) or an asphalt emulsion (per ASTM D1227).

The polyester-reinforced BUR system has several uses: for re-covering existing membranes, for new membranes; and for replacing old roofs requiring tearoff. In most instances, re-covering requires one or two plies of the spunbonded fabric, while new or retrofit BURs require two to four plies, depending on design requirements and weight of the spunbonded fabric.

The only change in conventional cold-process membranes involves the substitution of spunbonded polyester fabrics for the conventional organic or glass-fiber coated felts normally used in these membranes.

Use of cold mastic or cutback asphalt as binder and waterproofing medium for built-up membranes is many years old, an integral part of many cold-applied asphalt systems. Spunbonded polyester fabrics have also been available for many years, but their use in roofing is relatively new.

Spunbonded Polyester Fabrics

Polyesters are polymers formed when bifunctional glycols and bifunctional acids react to form long molecular polyester chains. Heated to high temperatures,the thermoplastic polyesters become fluid enough to pass through tiny spinneret holes to form continuous fibers (Fig.4). Collected in random orientations on a moving belt, these fibers form a web, bonded with heat and pressure to form a spunbonded fabric.

Spunbonded polyester fabrics are strong, tough, extensible, flexible, tear resistant, durable (e.g., nonbiodegradable), non-water-absorptive, and lightweight. These exceptional properties provide an extremely useful, nonwoven fabric with great potential as the reinforcing felts in BUR membranes.

In addition to their previously noted sensitivity to high temperatures, however, spunbonded polyester fabrics have another limitation that requries attention in all end-use applications, including BUR systems. Because of their low resistance to ultraviolet degradation, polyester fibers must be covered in all outdoor applications that require long service life. In roofing, the asphalt topcoat is an excellent barrier to ultraviolet radiation. A top layer of 60 lb/sq of mineral chips or 400 lb/sq of gravel, as in conventional BUR practice, provides additional protection to the whole roof.

Polyester-Reinforced Membrane Properties

The beneficial properties of spunbonded polyester fabrics carry over into the properties of the finished BUR membrane. The table shown in Fig. 5 compares the properties of three roofing systems, all using cold, cutback mastic as the binder and waterproofing medium. The first system comprises three plies of uncoated spunbonded polyester fabric, each weighing 1.5 lb/sq. The second has three plies of an uncoated, wet-process glass fiber mat weighing 1.4 lb/sq. The third system has three plies of 15-lb. organic asphalt-saturated felt. All test membranes had 2.5-3 gal/sq of mastic per layer and top coat.

After drying for one month in a laboratory, the tensile strengths of all three composites are approximately the same, but the other properties put the polyester membrane in a class by itself (see Fig. 5). Its breaking strain is 20 times greater than that of the membranes made with uncoated glass fiber mat or organic felts, both of which fail with a more brittle type of fracture.

The polyester felts' high breaking strain is correlated with **toughness**, high work-to-break, represented by the area under the stress-strain curve (Fig. 6), referred to in ASTM D-865, which combines both tensile stress and elongation.

The work-to-break or toughness of a polyester roof membrane is always very high (Fig. 7). High toughness indicates that much work must be expended on a polyester membrane before failure can occur.

Flexural fatigue of the polyester membrane is 100 to 1,000 times that of the other two membranes. Moreover, its trapezoid tear strength is two to three times that of the membrane made with uncoated glass mat reinforcement. The greater elongation, flexural fatigue resistance and tear strengths provide spunbonded-polyester-reinforced membranes with the potential for long service lives.

Case Histories

Cold-applied, polyester-reinforced membranes resurfacing or re-covering existing membranes made of other materials have compiled an impressive track recored. A 10-year-old roof in Philadelphia, with polyester-reinforced membrane and asphalt emulsion interply adhesive and top coating is still performing satisfactorily. The spunbonded polyester samples from this membrane show no loss in physical properties in laboratory tests. The same is true of many six-year-old polyester membranes in the northwestern United States.

In addition to **spunbonded** polyester, **spunlaced** polyester fabric fulfills a special need where the graveled surfacing of an existing roof is irregular. Spunbonded fabric is too stiff to conform to the contours of such roofs without bridging (see Fig. 8). The more flexible spunlaced polyester, however, will conform more closely to irregular surfaces, with consequent reduction in puncture hazard.

Spunlaced polyester fabrics are made with stable polyester fibers hydraulically entangeled to form a fabric (Fig. 9, Ref. 1). Fabric properties are similar to spunbonded polyester in elongation and flexural fatigue. But because it is held together by fiber entanglement, it is more drapable. It thus becomes an excellent membrane for repair of gravel-surfaced membranes, conforming to the surfacing without bridging.

Application technique is the same for spunlaced polyester as for spunbonded polyester, except that more cutback asphalt (7-9 gal/sq) is needed in the first ply when re-covering an irregular aggregate-surfaced membrane. Apart from the greater flexibility of spunlaced polyester, physical properties of membranes with spunlaced polyester are identical to those made with spunbonded polyester.

Other Prospects

Modified bitumen systems probably offer the best opportunity for exploiting the unique properties of spunbonded polyester fabrics as reinforcement in cold-process membranes. The relatively high breaking strain and elasticity of modified bitumen sheets should compliment the polyester's superior quality to produce exceptional membrane performance in cold-process membranes made with a cold solution (cutback) or emulsion adhesive.

The use of glass fiber products with spunbonded polyester apparently combines the best of two worlds. There is some commercial use of cold asphalt roofing systems in which a glass fiber product is used as a base sheet with one or two plies of spunbonded polyester as the upper layers. The fiberglass provides stiffness and gives a level surface. The spunbonded polyester provides high breaking strain and toughness. If the glass fiber base sheet developes a crack (Fig. 10), the polyester layers would pick up the load and function as if they were the only reinforcement. This phenomenon has been observed with both cold mastic binder systems as well as with hot asphalt co-coated glass mat and spunbonded polyester. It has been seen with glass scrims and polyester where the polyester fabric continued to reinforce the membrane after the glass scrim had fractured.

The combinations of materials that one can use with spunbonded polyester and the mannner of their use are expected to be limited only by the designer's imagination.

Acknowledgement

The first use of spunbonded polyester and cold mastic was used in re-cover sheets by Mr. Jerry Mylan of Seattle, Wash.

All of the test BUR work in Wilmington, DE, that lead to the development of the BUR technolgy-discussed in this paper was carried out with the cooperation of the Hurlock Roofing Co. in Wilmington.

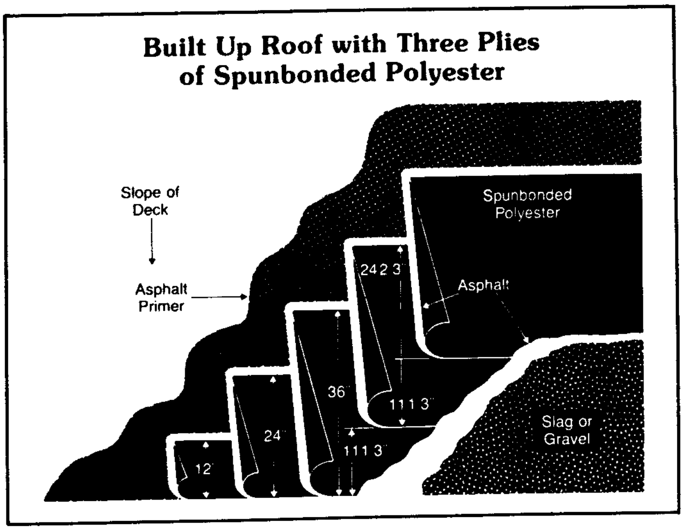


FIGURE 1
Three Plies of Spunbonded Polyester in Built Up Roof.

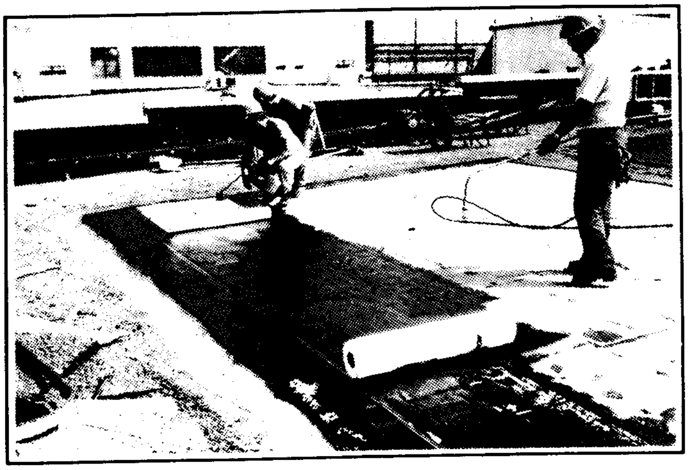


FIGURE 2

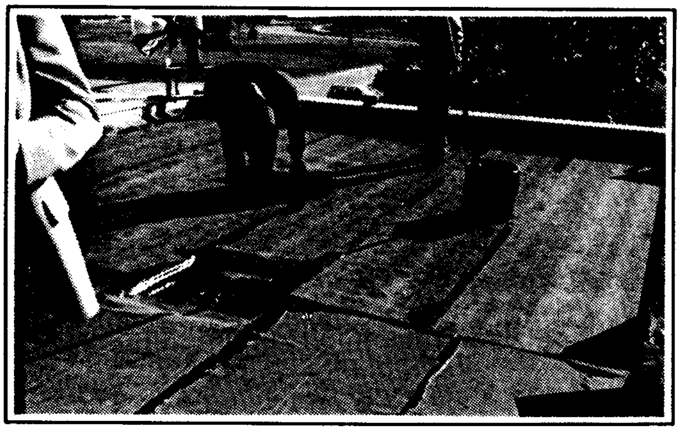
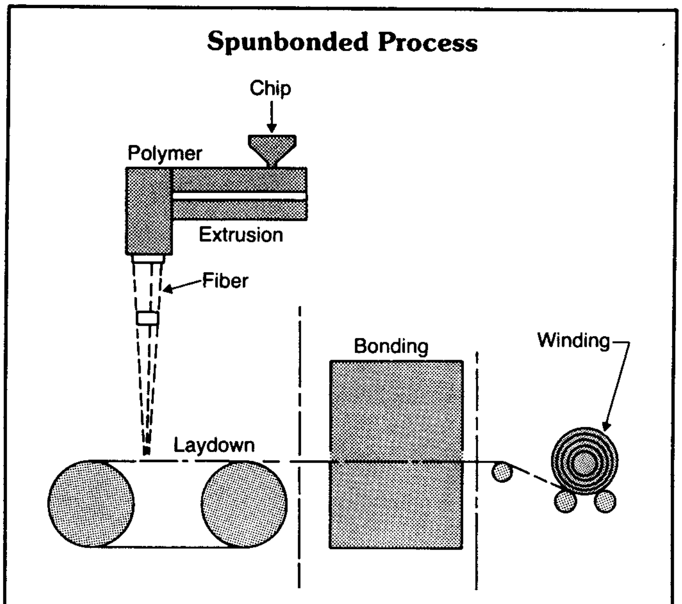


FIGURE 3



Ref: "Guide to Nonwoven Fabrics," INDA, New York, N.Y.

FIGURE 4

Properties of Roof Composites with Cold Mastic*

3 Layers of	Tensile[1] Lb./In. MD/XD**	Elongation[1] % MD/XD	Flex[2] Cycles MD/XD	Trapezoid[3] Tear Lb. MD/XD
Spunbonded Polyester (1.5 Lb./Square)	76/58	43/55	100,000	22/19
Glass Fiber Mat (1.4 Lb./Square)	72/42	1.8/2.5	1,000	10/7
Organic Felt (15 Lb. After Asphalt)	91/48	1.5/2.2	100	N.D.[4]

*2.5-3 Gallons/Square/Layer and Top Coat.
**MD/XD – Machine Direction/Cross Direction.
[1] ASTM D-2523
[2] ASTM D-813-59
[3] ASTM D-1117
[4] N.D. Not Determined

FIGURE 5
Properties of Roof Composites with Cold Mastic.

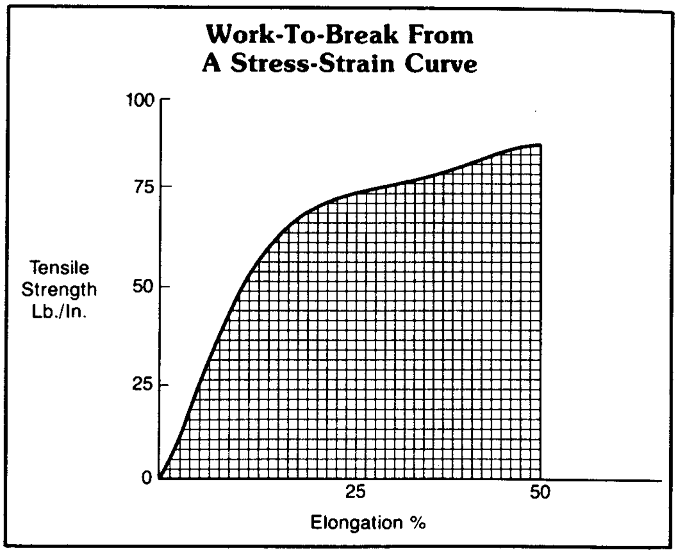


FIGURE 6
Work-to-Break as Area Under Stress-Strain Curve.

Work-to-Break of 3 Ply Roofs*

3 Plies of:	Work-to-Break (ASTM D-885) MD/XD**
Spunbonded Polyester	23/23
Glass Fiber Mat	0.7/0.8
15 Lb. Felt	0.9/0.9

*3 Gallons/Square of Cut-Back Used Per Layer of Product.
**MD/XD – Machine Direction/Cross Direction.

FIGURE 7
Work-to-Break of Roof Membranes.

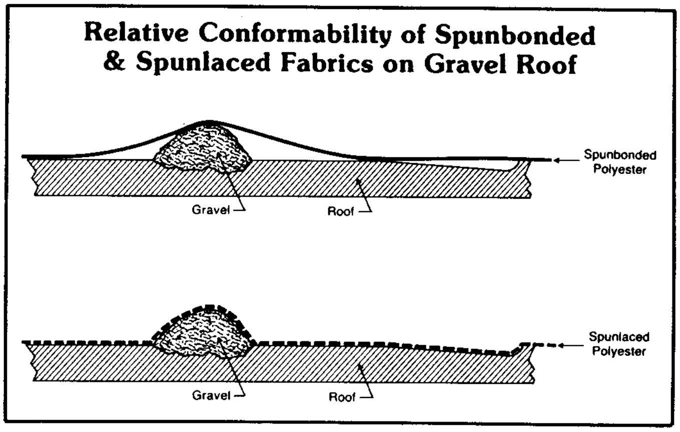
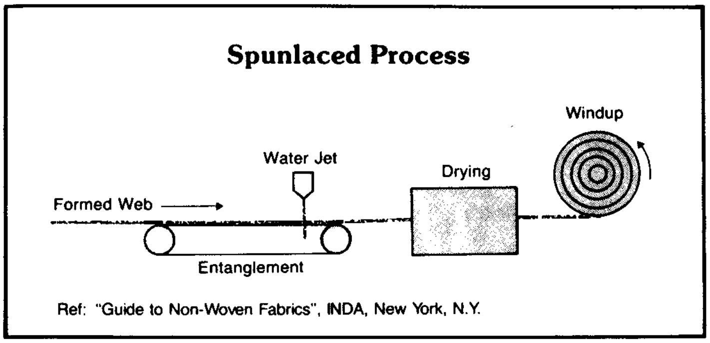


FIGURE 8



Ref: "Guide to Non-Woven Fabrics", INDA, New York, N.Y.

FIGURE 9
Diagram of a Typical Spunlaced Process.

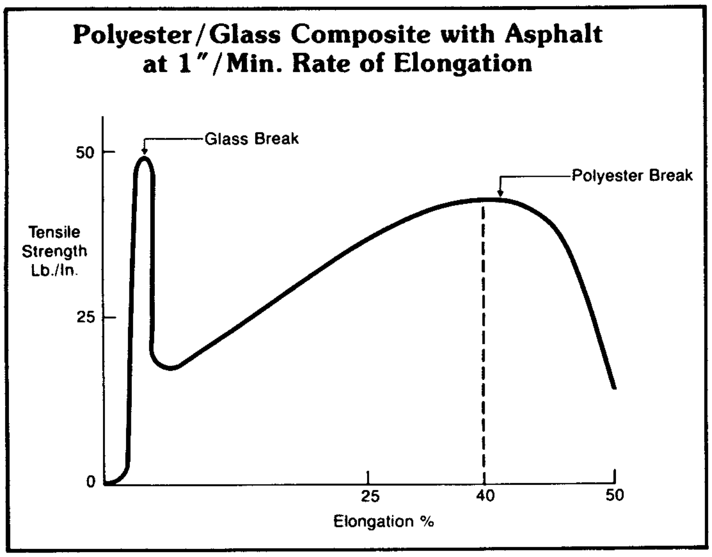


FIGURE 10
Stress-Strain Curve of a Glass/Polyester Membrane Composite.